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# CORE-COUPLED STATES EXCITED IN THE $^{208}\text{Pb}(d,t)^{207}\text{Pb}$ REACTION

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## ABSTRACT

A study of known core excited states in  $^{207}\text{Pb}$  shows that the cross section and analyzing power data are not well reproduced by two-step mechanisms.

## DISCUSSION

States up to an excitation energy of 3.8 MeV in  $^{207}\text{Pb}$  have been studied with the  $^{208}\text{Pb}(d,t)$  reaction at a bombarding energy of 17 MeV. Among the known core excited states in this region are the  $(^{208}\text{Pb}(3^-) \otimes p_{1/2}) 5/2^+, 7/2^+$  doublet near 2.6 MeV and the  $(^{208}\text{Pb}(g.s.) \otimes g_{9/2})$  state at 2.74 MeV. The former would be excited by a two-step process involving inelastic excitation while the latter should be excited by a  $(d,p)(p,t)$  sequential transfer two-step reaction. Given the relatively simple structure of these states, it was thought that measurements of analyzing power as well as cross section should provide a sensitive test of reaction theories for two-step processes.

The polarized deuteron beam from the LASL Van de Graaff accelerator was used in this investigation. The tritons were momentum analyzed in the Q3D spectrometer and detected in a helical wire focal plane detector. Differential cross sections, vector analyzing power ( $A_y$ ), and tensor analyzing powers ( $A_{yy}$ ) were measured for  $\theta_{lab}=10-60^\circ$ . The  $A_{yy}$  data are of reasonable quality for only the single-hole states.

Data for the single-neutron hole states in  $^{207}\text{Pb}$  provided a test of the optical model parameter sets to be employed in the subsequent two-step calculations. While the fits to these cross sections were fairly insensitive to the choice of parameter set, the fits to the analyzing powers provided a more stringent requirement. The one-step DWBA analysis was performed with the code DWUCK<sup>1</sup> and included first-order corrections for finite range and nonlocality. The best fit was obtained using the "best fit" deuteron set of

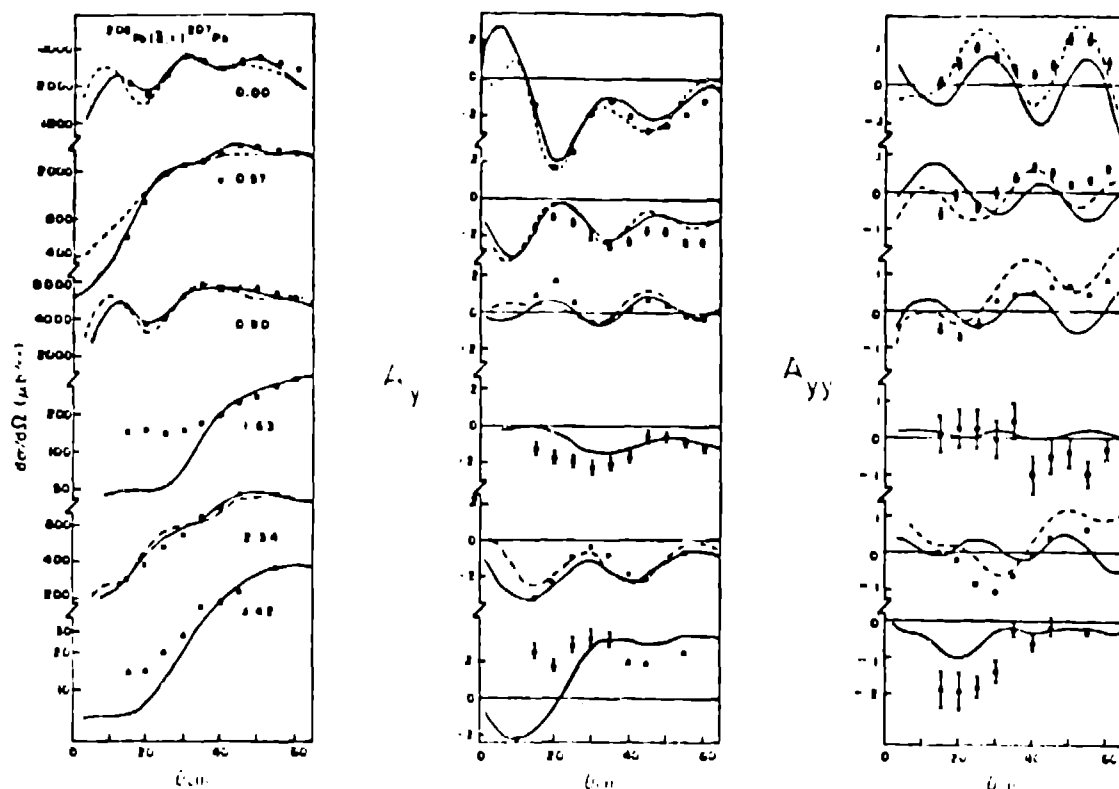


Fig. 1. Angular distributions for the single-hole states.

Childs *et al.*<sup>2</sup> and the global triton set of Becchetti and Greenlees.<sup>3</sup> These fits are shown in Fig. 1. The dashed lines indicate the predictions of the finite-range code DWUCK51 using the same parameters. The agreement with the  $A_{yy}$  data is improved by including the full finite range effects, while the quality of the fits to the cross section and  $A_y$  data is not significantly modified.

The assignment of the doublet near 2.6 MeV as  $(^{208}\text{Pb}(3^-) \otimes p_{1/2}^{-1})$  is based on its strong  $L=3$  excitation in inelastic scattering. Accordingly, a two-step calculation involving inelastic excitation plus  $p_{1/2}$  pickup is expected to reproduce the data. The solid curves in Fig. 2 show the two-step predictions calculated with the code CHUCK1 assuming inelastic excitation of the  $3^-$  state in  $^{208}\text{Pb}$  followed by a  $p_{1/2}$  transfer. The agreement with the data is very poor. If the Johnson-Soper prescription is used for the deuteron potential, the results are only slightly improved. The dot-dash curves in Fig. 2 present the result of such a calculation in which inelastic excitation of the  $3^-$  state is permitted in both the target and residual nuclei. Further calculations including plausible one-step contributions were unable to provide better agreement.

The  $2h-1p$  character of the  $9/2^+$  state at 2.74 keV is established by its strong excitation with  $\ell=4$  in the  $^{206}\text{Pb}(d,p)$  reaction. In this case it was expected that the reaction should be described by sequential  $(d,p)(p,t)$  transfer, plus a one-step component due to the  $2p-2h$  excitations in the  $^{208}\text{Pb}$  ground state. The pure  $(d,p)(p,t)$  sequential calculations using reaction strengths from the literature,

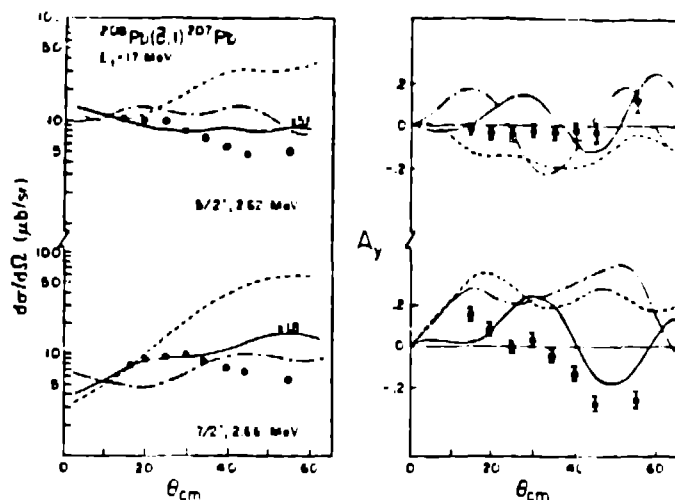


Fig. 2. Angular distributions for the  $^{208}\text{Pb}(d,t)^{207}\text{Pb}$  reaction to the multiplet at 2.6 MeV of excitation. Dashed curves are 1-step predictions normalized to the data.

yield the dot-dash curves in Fig. 3. The fits (dashed line) to back angle data assuming only a 1-step  $g_{9/2}$  pickup gives  $C^2S \approx 0.012$ . This value is lower than that obtained in previous studies.<sup>4</sup> The 1-step prediction appears to provide better agreement with the  $A_y$  than does the pure sequential calculation. The combined 1 and 2-step calculations (solid line) overpredicts the cross sections and provides only a marginal fit to the data. The 2-step contribution appears again to be too large.

In conclusion, we have been unable to obtain good agreement with measured cross sections using obvious reaction models based on the known properties of the states. Further calculations involving additional reaction channels are in progress and will be reported.

#### REFERENCES

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4. Moyer *et al.*, Phys. Rev. C **2**, 1898 (1971).

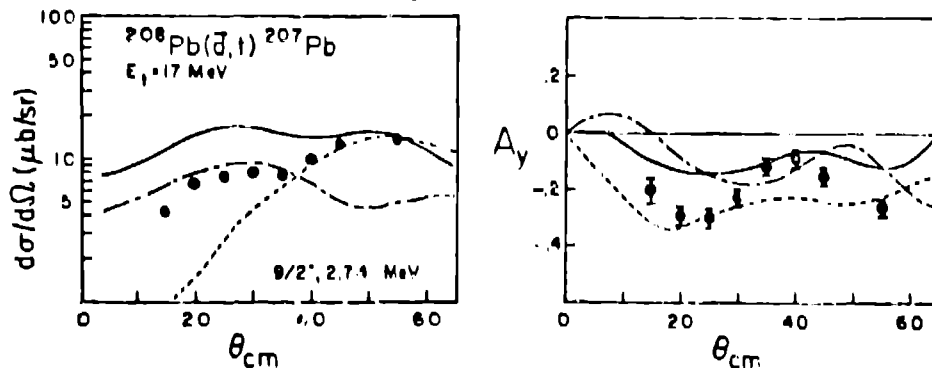


Fig. 3. Angular distributions for the  $^{208}\text{Pb}(d,t)^{207}\text{Pb}$  (2.74 MeV) reaction. Curves as described in the text.